C190-E251B

SHIMADZU
Excellence in Science

Packed Columns for Supercritical Fluid Chromatography

Shim-pack UC series

CoreFocus

Shim-pack™ UC Series Columns Achieve High Speed and High Resolution

The Shim-pack UC series columns offer a wide variety of stationary phases for separating all sorts of compounds using the unique characteristics of supercritical fluid chromatography (SFC). The series includes 20 kinds of packing materials and a wide range of particle and column sizes that can be selected based on the analyte.

SFC Characteristics

- SFC is characterized by higher mobile phase diffusivity than high performance liquid chromatography (HPLC), so separation behavior can vary significantly depending on the type of stationary phase used.
- Because separation is not sacrificed at high flow rates, analysis times can be shortened compared to HPLC analytical conditions.
- Due to the low viscosity and high diffusivity of supercritical carbon dioxide, it penetrates packing material surfaces and pores more readily than HPLC mobile phases. It may also improve the separation of isomers by promoting interactions with the stationary phase.

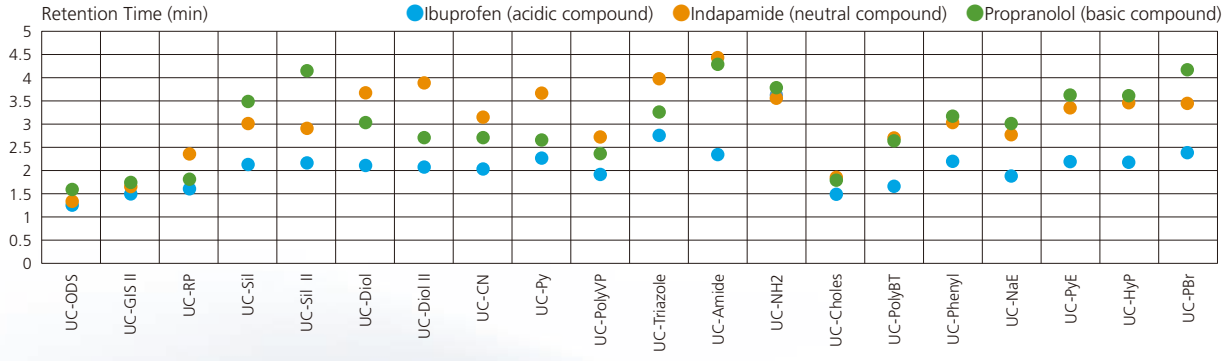
	Functional Group
Shim-pack UC-ODS	Octadecyl group
Shim-pack UC-GIS II*	Octadecyl group
Shim-pack UC-RP*	Octadecyl + polar functional group
Shim-pack UC-Sil*	—
Shim-pack UC-Sil II	—
Shim-pack UC-Diol*	Diol group
Shim-pack UC-Diol II	Diol group
Shim-pack UC-CN*	Cyanopropyl group
Shim-pack UC-Py	Pyridinyl group
Shim-pack UC-PolyVP	Poly (4-vinylpyridine) group
Shim-pack UC-Triazole	Triazole group

	Functional Group
Shim-pack UC-Amide*	Carbamoyl group
Shim-pack UC-NH2*	Aminopropyl group
Shim-pack UC-Choles	Cholesteryl group
Shim-pack UC-PolyBT	Polybutylene terephthalate (coated on silica gel)
Shim-pack UC-Phenyl*	Phenyl group
Shim-pack UC-NaE	Naphtylethyl group
Shim-pack UC-PyE	Pyrenylethyl group
Shim-pack UC-HyP	3-hydroxyphenyl group
Shim-pack UC-PBr	Pentabromobenzyl group

*Only available in 2.1 mm and 4.6 mm I.D. column sizes.

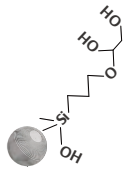
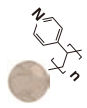
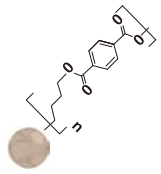
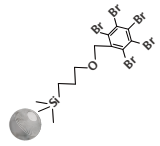
Retention Behavior of SFC Columns According to Compound Type

Since the hydrophobicity of supercritical carbon dioxide is similar to hexane, the primary separation behavior of SFC is considered generally similar to the normal phase mode. Depending on the stationary phase selected, other interactions can occur, such as pi-pi interactions or electrostatic reactions similar to HPLC. All 20 column types can be used for compounds with approximately neutral polarity. The figure below shows how retention behavior can vary significantly depending on the type of stationary phase used when analyzing typical acidic, neutral, or basic compounds. Stronger retention can be achieved by selecting a stationary phase expected to interact with the target compound.

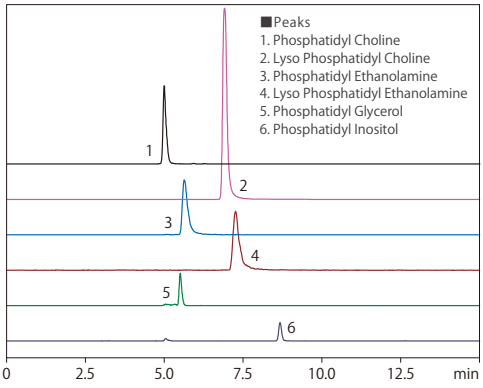


Selecting an SFC Column

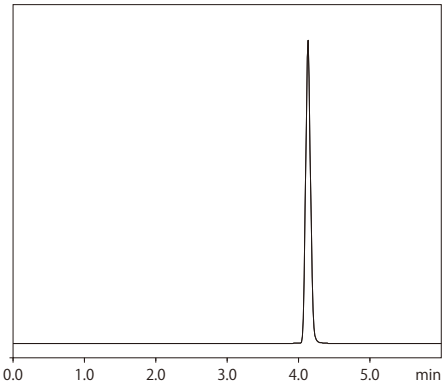
Since normal phase separation is the main separation mode used for SFC, normal phase UC-Diol and UC-Diol II are the most commonly used columns. They are followed by UC-Py columns, which exhibit similar behavior to ethylpyridine-based columns. HPLC involves using mobile phases with very different compositions for reverse phase and normal phase analysis, such as water-based versus non-water based mobile phases. In contrast, SFC uses a mixture of supercritical carbon dioxide and a modifier (an organic solvent such as methanol) regardless of the stationary phase used. Therefore, the same mobile phase composition can be used for serial analysis through all columns. Column scouting is effective by using the following set of 6 columns, each providing a different separation selectivity.

	6 columns set					
	UC-ODS	UC-Sil II	UC-Diol II	UC-PolyVP	UC-PolyBT	UC-PBr
Chemistry						
Features	The separation mode is reverse phase. Retention is provided through hydrophobic interaction.	This is excellent for retention of basic compounds and recognition of their tertiary structures.	The separation mode is normal phase. This inhibits non-specific interactions.	A favorable peak shape is obtained even without acid-base additives.	This is excellent for resolving aromatic compounds through π-π interactions.	With ODS, separation of poorly retained compounds is improved.

UC-Diol and UC-Diol II columns offer excellent general applicability for analyzing a wide variety of compounds, from phospholipids and other lipids to highly polar peptide compounds. However, a column with an ODS group stationary phase, such as the Shim-pack UC-ODS and Shim-pack UC-GIS II, must be used to separate phospholipids by molecular species with similar modifier parameters.

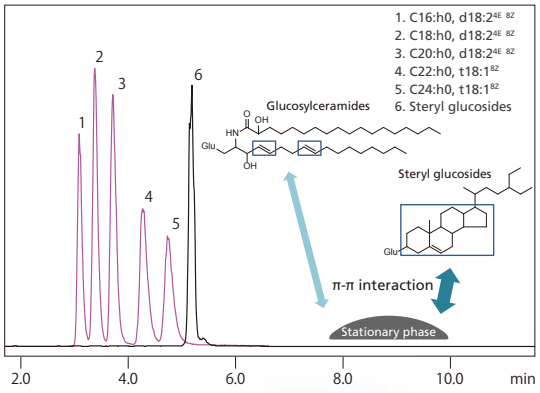


Analysis of Phospholipids (UC-Diol／UC-Diol II)

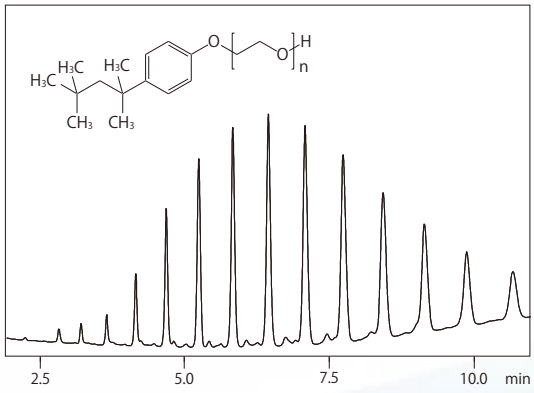


Analysis of Peptides (Cyclosporin A)

That means it may be possible to separate isomers and other compounds by SFC that are difficult to separate by HPLC. Columns with specific or multiple interaction modes may help improve separation. UC-PolyBT, with its high planar recognition capacity, and UC-PBr, with its dispersion power with Br, are useful.



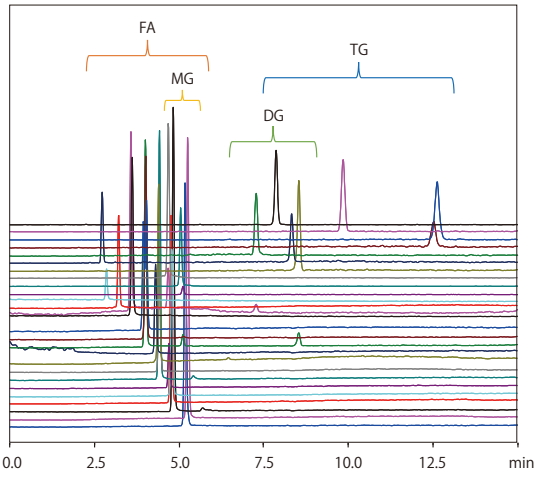
Analysis of Glucosylceramides and Steryl glucosides (UC-PolyBT)



Analysis of Triton X-100 (UC-PBr)

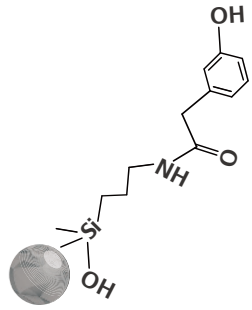
Analysis of a Wider Range of Low and High-Polarity Compounds

■ Simultaneous Analysis of Fatty Acids and Triglycerides (UC-HyP)



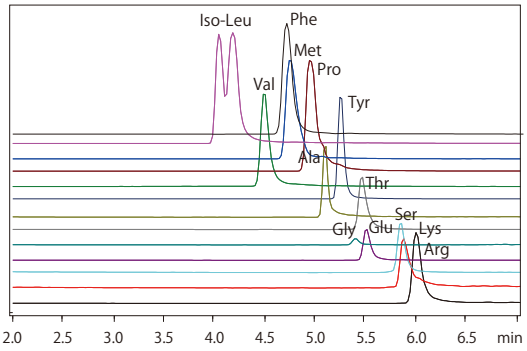
Simultaneous Analysis of Lipids

Different separation methods are generally used for fatty acids, which are typically analyzed by GC, and glycerides, which are typically analyzed by HPLC. However, because supercritical carbon dioxide has properties similar to hexane, SFC is well-suited for analyzing compounds with low polarity. UC-HyP columns can be used to simultaneously analyze everything from fatty acids to glycerides.



Shim-pack UC-HyP
(3-Hydroxyphenyl group)

■ Direct Analysis of Amino Acids and Other Highly Polar Compounds (UC-Amide)

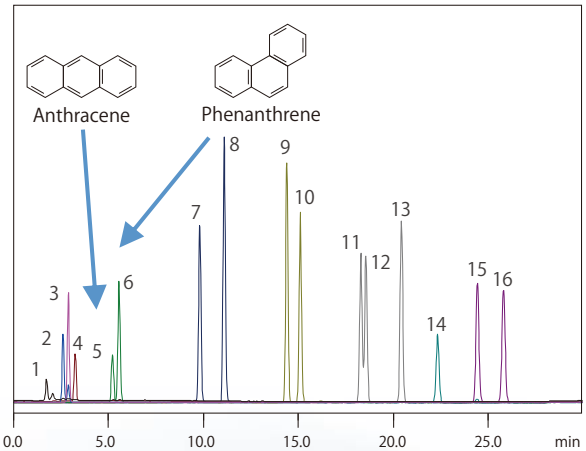


Simultaneous Analysis of Amino Acids

Highly polar compounds, such as amino acids, can be analyzed by selecting an appropriate stationary phase and modifier. By using a UC-Amide column, amino acids can be analyzed without the time and trouble of derivatization.

Especially Useful for Separating Isomers and Other Compounds

■ Separation of Isomers of Polycyclic Aromatic Hydrocarbons (PAH) (UC-Choles)

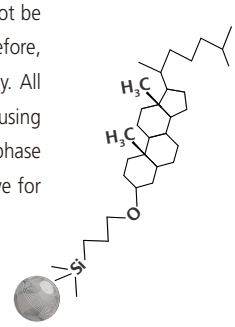


Analysis of 16 Polycyclic Aromatic Hydrocarbon Components

PAHs contain multiple isomers, such as anthracene and phenanthrene, which cannot be separated with a mass spectrometer. Therefore, they must be separated by chromatography. All five isomer combinations can be separated using a UC-Choles column. The rigid stationary phase structure of the cholesteryl group is effective for resolving similar planar compounds.

■Peaks

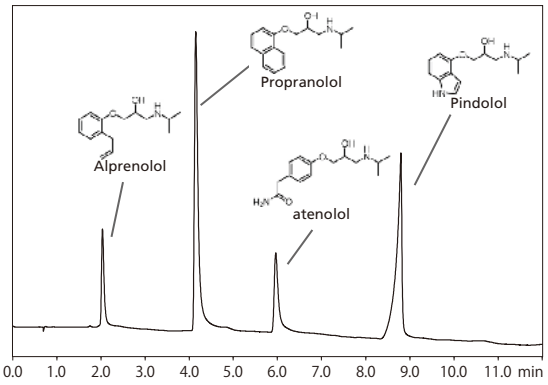
1. Naphthalene
2. Acenaphthylene
3. Acenaphthene
4. Fluorene
5. Anthracene
6. Phenanthrene
7. Fluoranthene
8. Pyrene
9. Benzo(a)anthracene
10. Chrysene
11. Benzo(k)fluoranthene
12. Benzo(b)fluoranthene
13. Benzo(a)pyrene
14. Dibenzo(a,h)anthracene
15. Indeno(1,2,3-cd)pyrene
16. Benzo(g,h,i)perylene



Shim-pack UC-Choles
(Cholesteryl group)

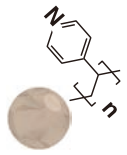
Obtain Favorable Peak Shapes Even without Acid-Base Additives

Improved peak shapes result from suppression of the ionization of target compounds and the masking of solid phase secondary functional groups through the addition of acids, such as formic acids, and bases, such as amines. In contrast, during fractionation, it may be preferable not to use additive agents depending on the intended use of the fraction. With UC-PolyVP, in which poly (4-vinylpyridine) is bound to a silica gel carrier, good peak shape can be obtained even without the addition of acids or bases.



Analysis of Basic β Blockers

When analyzing β blockers, which are basic compounds, sharp peaks are obtained even without the addition of salts. It is believed that poly(4-vinylpyridine), which is bonded to the polar silica gel surface, contributes to reducing interactions between the residual silanols and basic compounds.



Shim-pack UC-PolyVP
(Poly(4-Vinylpyridine) group)

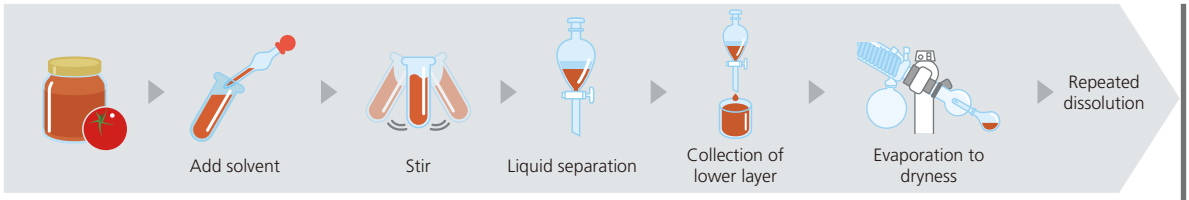
Using One Column for SFC and Online SFE-SFC

Shim-pack UC series columns can also be used for online SFE-SFC analysis, with all steps from extraction to analysis automated. When analyzing tomato paste automatically from extraction through separation and detection, pretreatment is complete in a mere five minutes, and the instrument automatically performs the subsequent extraction and analysis operations.

Typical sample preparation

... Requires **60 minutes** of sample preparation

60 min

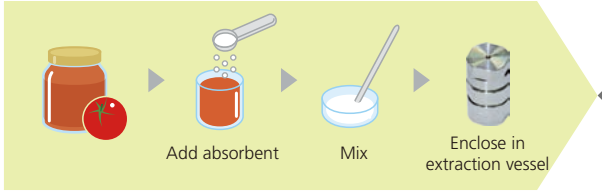


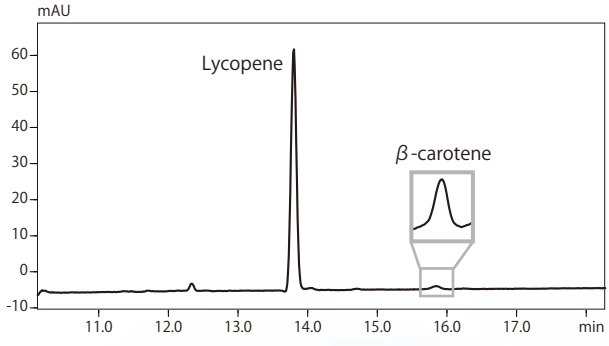
Nexera™ UC

... As little as 5 minutes to be ready for analysis

5 min

> 90% reduction





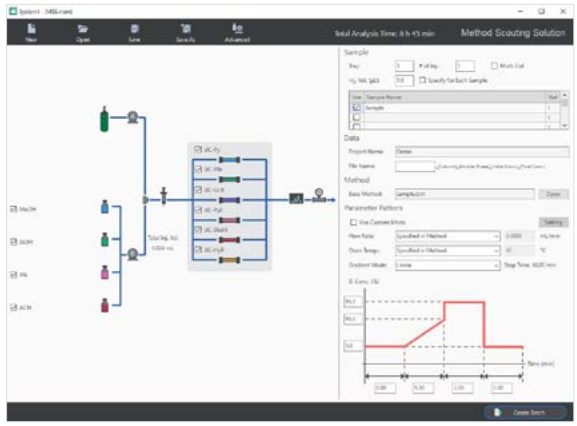
Chromatogram for the Tomato Paste Extract

Using UC-ODS, which features the octadecyl silyl group as the stationary phase, extraction of tomato paste was followed by separation and detection using online supercritical fluid chromatography. It was confirmed that lycopene indicated on the tomato paste package could be extracted. Fractionation is also possible by connecting a fraction collector.

Method Scouting Optimizes Separation Parameters and Scale-up to Preparative Work

High-purity preparative work requires proper separation between peaks. In order to achieve this, both an exhaustive investigation of conditions and the optimization of analytical conditions (method scouting) are important.

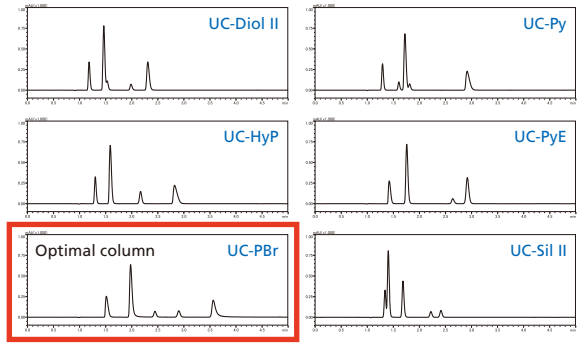
The Nexera UC chiral screening system with dedicated Method Scouting Solution software enables methods to be scouted quickly and accurately (Step 1). Once the optimal column is found, the method can be scaled up by using a preparative column with the same stationary phase. As a result, the sample load can be increased while maintaining the same separation performance (Step 2).



Method Scouting Solution Ver. 2

Step1 Method Scouting at the Analytical Scale

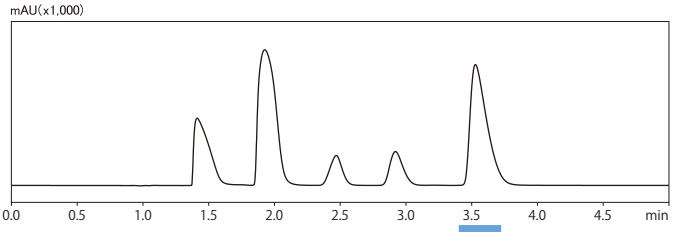
Even first-time users can perform method scouting by simply executing the batch table generated automatically by the dedicated software. Even if multiple modifiers and columns are involved, the system can automatically switch between different settings to execute the scouting process continuously day or night. Separation parameters can be evaluated either by visually checking results from multiple sets of data arranged in the Data Browser or by scoring the separation level in each set of data using multi-data report functionality.



Step2 Scaling Up from an Analytical Column to a Preparative Column

Sample loading can be increased while maintaining separation performance by using a Shim-pack UC series prep column. The stationary phase determined from the results in Step 1 can be used to scale up the column size, flowrate, and injection volume based on the desired fraction volumes.

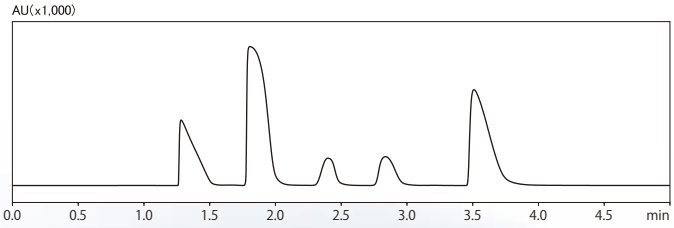
Column with 4.6 mm I.D. (Nexera UC)



Column : Shim-pack UC-PBr 4.6 × 250 mm
Flowrate : 3.0 mL/min
Injection Volume : 20 µL

Fraction Volume: 10 mg

Column with 20 mm I.D. (Nexera UC Prep)



Column : Shim-pack UC-PBr 20×250 mm
Flowrate : 56.7 mL/min
Injection Volume : 500 µL

Fraction Volume: 250 mg

An extensive line of stationary phases provides powerful support for analysis operations by ensuring a wide variety of analytical needs can be accommodated. Numerous column sizes and particle diameters can be selected to suit the analysis, from general-purpose to high-speed and high-separation analysis.

	I.D. × L (mm)	3 µm	5 µm
Shim-pack UC-ODS	2.1×150	227-32608-01	–
	3.0×50	227-32608-02	–
	3.0×100	227-32608-03	–
	3.0×150	227-32608-04	–
	4.6×250	–	227-32608-05
	10×50	–	227-32608-10
	10×250	–	227-32608-06
	20×50	–	227-32608-11
	20×250	–	227-32608-07
	28×250	–	227-32608-08
Shim-pack UC-GIS II	2.1×150	227-30404-03	227-30406-03
	2.1×250	227-30404-04	227-30406-04
	4.6×150	227-30405-03	227-30407-03
	4.6×250	227-30405-04	227-30407-04
Shim-pack UC-RP	2.1×150	227-30400-03	227-30402-03
	2.1×250	227-30400-04	227-30402-04
	4.6×150	227-30401-03	227-30403-03
	4.6×250	227-30401-04	227-30403-04
Shim-pack UC-Sil	2.1×150	227-30412-03	227-30414-03
	2.1×250	227-30412-04	227-30414-04
	4.6×150	227-30413-03	227-30415-03
	4.6×250	227-30413-04	227-30415-04
Shim-pack UC-Sil II	2.1×150	227-32607-01	–
	3.0×50	227-32607-07	–
	3.0×100	227-32607-08	–
	3.0×150	227-32607-09	–
	4.6×250	–	227-32607-02
	10×50	–	227-32607-10
	10×250	–	227-32607-03
	20×50	–	227-32607-11
	20×250	–	227-32607-04
	28×250	–	227-32607-05
Shim-pack UC-Diol	2.1×150	227-30408-03	227-30410-03
	2.1×250	227-30408-04	227-30410-04
	4.6×150	227-30409-03	227-30411-03
	4.6×250	227-30409-04	227-30411-04
Shim-pack UC-Diol II	2.1×150	227-32606-01	–
	3.0×50	227-32606-07	–
	3.0×100	227-32606-08	–
	3.0×150	227-32606-09	–
	4.6×250	–	227-32606-02
	10×50	–	227-32606-10
	10×250	–	227-32606-03
	20×50	–	227-32606-11
	20×250	–	227-32606-04
	28×250	–	227-32606-05
Shim-pack UC-CN	2.1×150	227-30428-03	227-30430-03
	2.1×250	227-30428-04	227-30430-04
	4.6×150	227-30429-03	227-30431-03
	4.6×250	227-30429-04	227-30431-04
Shim-pack UC-Py	2.1×150	227-32601-01	–
	3.0×50	227-32601-07	–
	3.0×100	227-32601-08	–
	3.0×150	227-32601-09	–
	4.6×250	–	227-32601-02
	10×50	–	227-32601-10
	10×250	–	227-32601-03
	20×50	–	227-32601-11
	20×250	–	227-32601-04
	28×250	–	227-32601-05

	I.D. × L (mm)	3 µm	5 µm
Shim-pack UC-PolyVP	2.1×50	227-32506-11	–
	2.1×100	227-32506-12	–
	2.1×150	227-32506-13	–
	3.0×50	227-32507-11	–
	3.0×100	227-32507-12	–
	3.0×150	227-32507-13	–
	4.6×50	227-32508-11	–
	4.6×100	227-32508-12	–
	4.6×150	227-32508-13	–
	4.6×250	227-32508-14	–
	4.6×150	–	227-32509-11
	4.6×250	–	227-32509-12
	10×250	–	227-32510-11
	20×250	–	227-32511-11
Shim-pack UC-Triazole	2.1×150	227-32605-01	–
	3.0×50	227-32605-07	–
	3.0×100	227-32605-08	–
	3.0×150	227-32605-09	–
	4.6×250	–	227-32605-02
	10×50	–	227-32605-10
	10×250	–	227-32605-03
	20×50	–	227-32605-11
	20×250	–	227-32605-04
	28×250	–	227-32605-05
Shim-pack UC-Amide	2.1×150	227-30416-03	227-30418-03
	2.1×250	227-30416-04	227-30418-04
	4.6×150	227-30417-03	227-30419-03
	4.6×250	227-30417-04	227-30419-04
Shim-pack UC-NH2	2.1×150	227-30420-03	227-30422-03
	2.1×250	227-30420-04	227-30422-04
	4.6×150	227-30421-03	227-30423-03
	4.6×250	227-30421-04	227-30423-04
Shim-pack UC-Choles	2.1×150	227-32603-01	–
	3.0×50	227-32603-07	–
	3.0×100	227-32603-08	–
	3.0×150	227-32603-09	–
	4.6×250	–	227-32603-02
	10×50	–	227-32603-10
	10×250	–	227-32603-03
	20×50	–	227-32603-11
	20×250	–	227-32603-04
	28×250	–	227-32603-05
Shim-pack UC-PolyBT	2.1×50	227-32500-11	–
	2.1×100	227-32500-12	–
	2.1×150	227-32500-13	–
	3.0×50	227-32501-11	–
	3.0×100	227-32501-12	–
	3.0×150	227-32501-13	–
	4.6×50	227-32502-11	–
	4.6×100	227-32502-12	–
	4.6×150	227-32502-13	–
	4.6×250	227-32502-14	–
	4.6×150	–	227-32503-11
	4.6×250	–	227-32503-12
	10×250	–	227-32504-11
	20×250	–	227-32505-11
Shim-pack UC-Phenyl	2.1×150	227-30424-03	227-30426-03
	2.1×250	227-30424-04	227-30426-04
	4.6×150	227-30425-03	227-30427-03
	4.6×250	227-30425-04	227-30427-04

	I.D. × L (mm)	3 µm	5 µm
Shim-pack UC-NaE	2.1×150	227-32609-01	–
	3.0×50	227-32609-02	–
	3.0×100	227-32609-03	–
	3.0×150	227-32609-04	–
	4.6×250	–	227-32609-05
	10×50	–	227-32609-10
	10×250	–	227-32609-06
	20×50	–	227-32609-11
	20×250	–	227-32609-07
	28×250	–	227-32609-08
Shim-pack UC-PyE	2.1×150	227-32604-01	–
	3.0×50	227-32604-07	–
	3.0×100	227-32604-08	–
	3.0×150	227-32604-09	–
	4.6×250	–	227-32604-02
	10×50	–	227-32604-10
	10×250	–	227-32604-03
	20×50	–	227-32604-11
	20×250	–	227-32604-04
	28×250	–	227-32604-05
Shim-pack UC-HyP	2.1×150	227-32600-01	–
	3.0×50	227-32600-07	–
	3.0×100	227-32600-08	–
	3.0×150	227-32600-09	–
	4.6×250	–	227-32600-02
	10×50	–	227-32600-10
	10×250	–	227-32600-03
	20×50	–	227-32600-11
	20×250	–	227-32600-04
	28×250	–	227-32600-05

	I.D. × L (mm)	3 µm	5 µm
Shim-pack UC-PBr	2.1×150	227-32602-01	–
	3.0×50	227-32602-07	–
	3.0×100	227-32602-08	–
	3.0×150	227-32602-09	–
	4.6×250	–	227-32602-02
	10×50	–	227-32602-10
	10×250	–	227-32602-03
	20×50	–	227-32602-11
	20×250	–	227-32602-04
	28×250	–	227-32602-05
Shim-pack UC-ODS (G)	10×20	–	227-32608-09
Shim-pack UC-Sil II (G)	10×20	–	227-32607-06
Shim-pack UC-Diol II (G)	10×20	–	227-32606-06
Shim-pack UC-Py (G)	10×20	–	227-32601-06
Shim-pack UC-Triazole (G)	10×20	–	227-32605-06
Shim-pack UC-Choles (G)	10×20	–	227-32603-06
Shim-pack UC-NaE (G)	10×20	–	227-32609-09
Shim-pack UC-PyE (G)	10×20	–	227-32604-06
Shim-pack UC-HyP (G)	10×20	–	227-32600-06
Shim-pack UC-PBr (G)	10×20	–	227-32602-06

Column Pressure Capacity
- 3 µm particle diameter: 50 MPa
- 5 µm particle diameter (with 2.1 to 10 mm I.D.): 30 MPa
- 5 µm particle diameter (with 20 to 28 mm I.D.): 23 MPa

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